AMENDMENTS TO THE CLAIMS:

This listing of claims will replace all prior versions, and listings, of claims in the application:

1. (Currently amended) A hydraulic control valve comprising:

a piezoelectric actuator including a deformable element made of a material which produces a mechanical deformation under application of a voltage, said piezoelectric actuator being so designed that an increase in output force of said piezoelectric actuator results in a decrease in allowable applied energy to said piezoelectric actuator, which is caused by production of charges in said piezoelectric actuator as a function of the increase in output force of said piezoelectric actuator; and

a hydraulic valve mechanism working to convert the deformation of said piezoelectric actuator into a hydraulic pressure to move a valve member hydraulically for opening and closing a fluid port selectively, said hydraulic valve mechanism being so designed that said piezoelectric actuator produces a maximum output force working to develop the hydraulic pressure when opening the fluid port through the valve member, the maximum output force decreasing after the fluid port is opened ~~and being set smaller than one-half of a maximum possible output force of said piezoelectric actuator under application of a maximum working voltage to said piezoelectric actuator~~, said hydraulic valve mechanism including a first and a second piston, the first piston working to convert the deformation of said piezoelectric actuator into the hydraulic pressure which acts on the second piston to move the valve member, a diameter ratio of the first piston to the second piston being so determined that the maximum output force of said piezoelectric actuator when opening the fluid port is set smaller than one-half of the maximum possible output force of said piezoelectric actuator under application of a maximum working voltage to said piezoelectric actuator.

2. (Original) A hydraulic control valve as set forth in claim 1, wherein said hydraulic valve mechanism includes a large-diameter piston and a small-diameter

piston, the large-diameter piston working to convert the deformation of said piezoelectric actuator into the hydraulic pressure, the hydraulic pressure acting on the small-diameter piston to move the valve member for opening the fluid port, the hydraulic pressure being amplified as a function of a diameter ratio of the large-diameter piston to the small-diameter piston, and wherein the diameter ratio is so determined that the maximum output force of said piezoelectric actuator when opening the fluid port is set smaller than one-half of the maximum possible output force thereof.

3. (Original) A hydraulic control valve as set forth in claim 1, wherein the maximum output force acting on the hydraulic pressure when opening the fluid port through the valve member is set greater than or equal to one-fourth of the maximum possible output force of said piezoelectric actuator.

4. (Currently amended) A fuel injector comprising:

a fuel spray mechanism working to spray fuel; and

a hydraulic control valve including a piezoelectric actuator and a hydraulic valve mechanism working to actuate said fuel spray mechanism, said piezoelectric actuator including a deformable element made of a material which produces a mechanical deformation under application of a voltage, said piezoelectric actuator being so designed that an increase in output force of said piezoelectric actuator results in a decrease in allowable applied energy to said piezoelectric actuator, which is caused by production of charges in said piezoelectric actuator as a function of the increase in output force of said piezoelectric actuator;

said hydraulic valve mechanism working to convert the deformation of said piezoelectric actuator into a hydraulic pressure to move a valve member hydraulically for opening and closing a fluid port selectively, thereby controlling a second hydraulic pressure serving to actuate said fuel spray mechanism, said hydraulic valve mechanism being so designed that said piezoelectric actuator produces a maximum output force working to develop the hydraulic pressure when opening the fluid port through the

valve member, the maximum output force decreasing after the fluid port is opened~~and being set smaller than one-half of a maximum possible output force of said piezoelectric actuator under application of a maximum working voltage to said piezoelectric actuator~~, said hydraulic valve mechanism including a first and a second piston, the first piston working to convert the deformation of said piezoelectric actuator into the hydraulic pressure which acts on the second piston to move the valve member, a diameter ratio of the first piston to the second piston being so determined that the maximum output force of said piezoelectric actuator when opening the fluid port is set smaller than one-half of the maximum possible output force of said piezoelectric actuator under application of a maximum working voltage to said piezoelectric actuator.

5. (Original) A fuel injector as set forth in claim 4, wherein said fuel spray mechanism includes a hydraulic control chamber in which a hydraulic pressure is developed and controlled by opening and closing the fluid port selectively through the valve member of said hydraulic valve mechanism to establish and block fluid communication between the hydraulic control chamber and a low-pressure passage, respectively, and wherein the hydraulic pressure in the hydraulic control chamber works to move a nozzle needle to open or close a spray hole for initiating or terminating fuel injection.

6. (Original) A fuel injector as set forth in claim as set forth in claim 5, wherein said hydraulic valve mechanism includes a hydraulic chamber in which the deformation of said piezoelectric actuator is converted into the hydraulic pressure and changed in level as a function of the deformation of said piezoelectric actuator, the hydraulic pressure in the hydraulic chamber of said hydraulic valve mechanism working to move the valve member to open the fluid port, thereby establishing the fluid communication between the hydraulic control chamber and the low-pressure passage to decrease the hydraulic pressure in the hydraulic control chamber for initiating the fuel injection.

7. (Original) A fuel injector as set forth in claim 4, wherein the maximum output force acting on the hydraulic pressure when opening the fluid port through the valve member is set greater than or equal to one-fourth of the maximum possible output force of said piezoelectric actuator.

Claim 8. (Canceled).

9. (Currently amended) A hydraulic control valve ~~as set forth in claim 8~~ comprising:

an actuator working to be deformed mechanically under application of an electric energy; and

a hydraulic valve mechanism working to convert deformation of said actuator into a hydraulic pressure and to change the hydraulic pressure as a function of the deformation of said actuator to move a valve member for closing either of a high-pressure port leading to a high-pressure passage and a low-pressure port leading to a low-pressure passage,

wherein

when the electric energy is applied to said actuator, said hydraulic valve mechanism working to open the low-pressure port through the valve member while closing the high-pressure port,

when the electric energy is released from said actuator, said hydraulic valve mechanism working to open the high-pressure port while closing the low-pressure port, said hydraulic valve mechanism being so designed that the electric energy to be applied to said actuator when opening the low-pressure port is greater than or equal to an electric energy required to close the high-pressure port, and

wherein said hydraulic valve mechanism includes a hydraulic chamber in which the deformation of said actuator is converted into the hydraulic pressure of a working fluid and changed in level as a function of the deformation of said actuator and a piston

on which the hydraulic pressure acts to move the valve member so that the valve member rests on one of a low-pressure port seat formed around the low-pressure port and a high-pressure port seat formed around the high-pressure port, and wherein said hydraulic valve mechanism is so designed as to meet a relation below

$$S_H \cdot P \cdot L + \tfrac{1}{2} \cdot (S_H \cdot P/s)^2 \cdot V/r \leqq \tfrac{1}{2} \cdot (S_L \cdot P/s)^2 \cdot V/r$$

where S_L is an area (mm^2) of the low-pressure port seat, S_H is an area (mm^2) of the high-pressure port seat, V is a volume (mm^3) of the hydraulic chamber, r is a bulk modulus (Kg/mm^2) of the working fluid in the hydraulic chamber, s is an area (mm^2) of the piston on which the hydraulic pressure acts, L is a distance (mm) the valve member travels from the low-pressure port to the high-pressure port, and P is a pressure (Kg/mm^2) in the high-pressure passage.

10. (Currently amended) A hydraulic control valve as set forth in claim ~~8~~ 9, wherein said actuator is implemented by one of a piezoelectric actuator and a magnetostrictive actuator.

11. (Currently amended) A fuel injector comprising:

a fuel spray mechanism working to spray fuel; and

a hydraulic control valve including a piezoelectric actuator and a hydraulic valve mechanism working to actuate said fuel spray mechanism, said actuator working to be deformed mechanically under application of an electric energy, said hydraulic valve mechanism working to convert deformation of said actuator to move a valve member for closing either of a high-pressure port leading to a high-pressure passage and a low-pressure port leading to a low-pressure passage to control a second hydraulic pressure serving to actuate said fuel spray mechanism, when the electric energy is applied to said actuator, said hydraulic valve mechanism working to pen the low-pressure port through the valve member while closing the high-pressure port, when the electric energy is released from said actuator, said hydraulic valve mechanism working to pen

the hydraulic valve mechanism being so designed that the electric port is greater than or equal to an electric energy required to close the high-pressure port.

a voltage, said piezoelectric actuator being so designed that an increase in output force of said piezoelectric actuator results in a decrease in electric energy suppliable to said piezoelectric actuator which is caused by production of chares in said piezoelectric actuator as a function of the increase in output force of said piezoelectric actuator;

said hydraulic valve mechanism working to convert the deformation of said piezoelectric actuator into a hydraulic pressure to move a valve member hydraulically for opening and closing a fluid port selectively, thereby controlling a second hydraulic pressure serving to actuate said fuel spray mechanism, said hydraulic valve mechanism being so designed that said piezoelectric actuator produces a maximum output force working to develop the hydraulic pressure when opening the fluid port through the valve member, the maximum output force decreasing after the fluid port is opened, said hydraulic valve mechanism including a first and a second piston, the first piston working to convert the deformation of said piezoelectric actuator into the hydraulic pressure which acts on the second piston to move the valve member, a diameter ratio of the first piston to the second piston being so determined that the maximum output force of said piezoelectric actuator when opening the fluid port is set smaller than one-half of the maximum possible output force of said piezoelectric actuator under application of a maximum working voltage to said piezoelectric actuator,

wherein said hydraulic valve mechanism includes a hydraulic chamber in which the deformation of said actuator is converted into the hydraulic pressure of a working fluid and changed in level as a function of the deformation of said actuator and a piston on which the hydraulic pressure acts to move the valve member so that the valve member rests on one of a low-pressure port seat formed around the low-pressure port and a high-pressure port seat formed around the high-pressure port, and wherein said hydraulic valve mechanism is so designed as to meet a relation below

$$S_H \cdot P \cdot L + \tfrac{1}{2} \cdot (S_H \cdot P/s)^2 \cdot V/\gamma \leq \tfrac{1}{2} \cdot (S_L \cdot P/s)^2 \cdot V/\gamma$$

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where S_L is an area (mm^2) of the low-pressure port seat, S_H is an area (mm^2) of the high-pressure port seat, V is a volume (mm^3) of the hydraulic chamber, γ is a bulk modulus (Kg/mm^2) of the working fluid in the hydraulic chamber, s is an area (mm^2) of the piston on which the hydraulic pressure acts, L is a distance (mm) the valve member travels from the low-pressure port to the high-pressure port, and P is a pressure (Kg/mm^2) in the high-pressure passage.

12. (Original) A hydraulic control valve as set forth in claim 11, wherein said actuator is implemented by one of a piezoelectric actuator and a magnetostrictive actuator.

13. (New) A hydraulic control valve as set forth in claim 1, wherein the first piston is opposed to the second piston through a hydraulic chamber, and wherein a ratio of a pressure-energized area of the first piston on which a hydraulic pressure within the hydraulic chamber acts to that of the second piston on which the hydraulic pressure within the hydraulic chamber acts is greater than or equal to 1.17 and smaller than 2.3.

14. (New) A hydraulic control valve as set forth in claim 1, wherein when the electric energy is supplied to said piezoelectric actuator, the valve member is moved to close a high-pressure hydraulic port and open a low-pressure hydraulic port for opening the fluid port.

15. (New) A hydraulic control valve as set forth in claim 14, further comprising a pressure control chamber communicating with the high-pressure hydraulic port and the low-pressure hydraulic port, and wherein when the electric energy is supplied to said piezoelectric actuator, said piezoelectric actuator works to move the valve member to close the high-pressure hydraulic port while opening the low-pressure hydraulic port

to decrease a hydraulic pressure within the pressure control chamber, thereby opening the fluid port.

16. (New) A hydraulic control valve as set forth in claim 4, wherein the first piston is opposed to the second piston through a hydraulic chamber, and wherein a ratio of a pressure-energized area of the first piston on which a hydraulic pressure within the hydraulic chamber acts to that of the second piston on which the hydraulic pressure within the hydraulic chamber acts is greater than or equal to 1.17 and smaller than 2.3.

17. (New) A hydraulic control valve as set forth in claim 4, wherein when the electric energy is supplied to said piezoelectric actuator, the valve member is moved to close a high-pressure hydraulic port and open a low-pressure hydraulic port for opening the fluid port.

18. (New) A hydraulic control valve as set forth in claim 17, further comprising a pressure control chamber communicating with the high-pressure hydraulic port and the low-pressure hydraulic port, and wherein when the electric energy is supplied to said piezoelectric actuator, said piezoelectric actuator works to move the valve member to close the high-pressure hydraulic port while opening the low-pressure hydraulic port to decrease a hydraulic pressure within the pressure control chamber, thereby opening the fluid port.